Spin configuration of Gd clusters and thin films (abstract)

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Studies of the magnetism and structure of Gd clusters and surfaces will be presented.[1] The spin configuration of a Gd_{13} cluster and the Gd(0001) surface has been examined using electronic structure calculations as well as a Heisenberg model. Structural calculations show that the ground-state geometry of the cluster has a hcp arrangement with a slightly reduced nearest-neighbor distance compared to bulk and an average moment of 7.8 μ_B/atom. The Heisenberg model is calculated using a Ruderman-Kittel-Kasuya-Yosida-like interaction. The effects of competing ferromagnetic and antiferromagnetic coupling for the nearest- and next-nearest neighbor interaction, respectively, is investigated. It is shown that for a range of interaction strengths the spins in the cluster assume a canted configuration. This effect leads to lower net magnetization of the cluster, and accounts for the anomalous low moments of Gd_n clusters that have been experimentally observed. A similar model of the Gd(0001) surface agrees well with earlier spin resolved low-energy electron diffraction experiments from Gd/W(110), and spin resolved secondary electron spectroscopy studies of the surface magnetism of Gd grown on Y(0001) will be presented. [S0021-8979(97)85008-6]

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Magnetism of Gd and Tb nanoscale particles (abstract)

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We have prepared Gd and Tb particles in a matrix of Ti by sputtering to understand the effects of finite size and large interface area on the magnetic properties of magnetic systems with large anisotropy. Ti is chosen as the matrix since Gd and Tb have low miscibility in it. Electron microscopy shows that the particle diameters for a given sample have a distribution characterized by a standard deviation that ranges from 15% to 25% of the mean value. We have already shown that the coercivity in nanoscale Tb particles at 4.5 K is enhanced over that in thick films by a factor of 2.4 reaching a value of 22 kOe for particles of average diameter of 7 nm.[1] Here, we find that in the Gd particles the coercivity at 4.5 K and transition temperature are reduced for particles with average diameter below about 10 nm. The coercivity in the Gd particles is more than a factor of 10 smaller than for Tb particles due to the lack of any significant microscopic anisotropy in the Gd system (Gd is an *s*-state ion in its metallic state). A strong time dependence of the magnetization is observed in the Tb particle systems for particle diameters above about 5 nm while only a weak time dependence is seen in the Gd systems for all particle diameters studied. We find that in the Tb system the relaxation rate as characterized by the magnetic viscosity S shows a maximum as a function of temperature in the range 6–20 K. We shall discuss these results in terms of models involving finite size and strong magnetic anisotropy.
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